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METHOD FOR FABRICATING LIQUID CRYSTAL DISPLAY DEVICE AND SEALING MATERIAL THEREFOR

[Abstract]

PROBLEM TO BE SOLVED: To provide a manufacturing method for liquid crystal display which can hermetically charge a liquid crystal composition in a short time and stably mass-produce a liquid crystal display with good display quality and a sealing material which is applied to this liquid crystal display.

SOLUTION: By this manufacturing method for liquid crystal display device, a couple of substrates are stuck together by applying the sealing material 106 to one substrate 400M in a looped shape, dripping the liquid crystal composition in a liquid crystal charged area 402 in the loop applied with the sealing material 106, putting the other substrate 600M on the substrate 400M in a vacuum state, pressing the substrates until their gap decreases to a specific interval, and then

hardening the sealing material 106. Here, the solubility of the sealing material 106 in the liquid crystal composition is ≤ 100 ppm from the application to the hardening of the sealing material 106 on the substrate.

[Claims]

[Claim 1] A method for fabricating a liquid crystal display device comprising: applying a sealing material to at least one of a first substrate and a second substrate in the shape of a frame; dropping a liquid crystal composition inside the sealing material applied in the shape of a frame; injecting and sealing the liquid crystal composition in a predetermined gap between a couple of substrates by putting and pressing the second substrate on the first substrate; and hardening the sealing material, wherein the solubility of the sealing material for the liquid crystal composition is below 100 ppm between an application and a hardening of the sealing material.

[Claim 2] A sealing material used for bonding a first substrate and a second substrate and contacting with a liquid crystal composition, wherein the solubility of the sealing material for the liquid crystal composition is below 100 ppm.

[Title of the Invention]

METHOD FOR FABRICATING LIQUID CRYSTAL DISPLAY DEVICE AND SEALING MATERIAL THEREFOR

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to a sealing material for a liquid crystal display device (LCD) and a method for fabricating an LCD, and more particularly, to a method for fabricating an LCD which injects and seals a liquid crystal composition in a short time.

[Description of the Prior Art]

Recently, an LCD has been used in various fields taking advantage of characteristics of a light weight, miniaturization and low power consumption. Especially, the LCD, wherein a Twisted Nematic (TN) type liquid crystal composition is kept between a couple of electrode substrates, is widely used.

As a method for disposing a liquid crystal composition between a couple of electrode substrates, for example, a vacuum injection method or a dropping injection method are known.

In the vacuum injection method, after bonding two glass substrates by a sealing material consisted of an adhesive, an empty liquid crystal cell is formed by hardening a sealing material. At this time, the sealing material is applied except for a part corresponding to a liquid crystal inlet. Then, the empty liquid crystal cell is put into a vacuum chamber, a pressure becomes reduced inside, and an air in the liquid crystal cell is exhausted. And after dipping the liquid crystal inlet in a boat containing a liquid crystal composition, the inside of the vacuum chamber is returned to an atmospheric pressure, thereby the liquid crystal cell is filled by

inhaling the liquid crystal composition fro the liquid crystal inlet due to a difference between the pressure in the liquid crystal cell and the pressure in the vacuum chamber.

By the vacuum injection method, about 7 to 10 hours are required to inject a general-purpose positive type liquid crystal composition. Also, when a size of a panel becomes larger or a cell gap becomes smaller or a negative type liquid crystal composition such as MVA, etc. is injected, much longer duration is required.

Meanwhile, the dropping injection method is a method of applying a sealing material to one substrate in the shape of a frame, dropping a liquid crystal composition in a frame on a substrate, and put the substrate on the other substrate in vacuum, as known in JP, 61-260216, A. In order to form a desired cell gap between a couple of substrates, it is necessary to leave it in an atmosphere and press by atmospheric pressure, or to press mechanically.

By the dropping injection method, it is possible to form a liquid crystal layer in a short time of about 1 hour, without regard for a size of a panel, a cell gap, or characteristics of a liquid crystal composition used.

[Problem(s) to be solved by the Invention]

However, such a dropping injection method has a following problem. That is, since a sealing material contacts with a liquid crystal composition before hardening, components of a sealing material are melt into a liquid crystal composition and pollute it, thereby a poor display generates.

For this reason, in JP, 5-265012, A, and JP, 8-190099, A, etc., there is proposed a method of hardening the surface of a sealing material contacting with a liquid crystal composition before dropping it. Also, in JP, 11-109388, A etc., there is proposed a method of hardening a sealing material before a liquid crystal

composition spreads and contacts with a sealing material.

However, all the methods have problems that a sealing material is hardened before pressing to make a desired cell gap of a liquid crystal layer, a sealing material is difficult to be pressed, and a desired cell gap can not be secured. For this reason, an LCD, which display quality is stably good, can not be fabricated in large quantities.

The present invention is made considering the above problems. An object of the present invention is to provide a method for fabricating a liquid crystal display device (LCD) capable of injecting and sealing a liquid crystal composition in a short time, and of mass-producing a liquid crystal display device having a stably good display quality and a sealing material for an LCD.

[Means for solving the Problem]

To achieve the object, there is provided a method for fabricating a liquid crystal display device, the method including; applying a sealing material to at least one of a first substrate or a second substrate in the shape of a frame; dropping a liquid crystal composition inside the sealing material applied in the shape of a frame; injecting and sealing the liquid crystal composition in a predetermined gap between a couple of substrates by putting and pressing the second substrate on the first substrate; and hardening the sealing material, wherein the solubility of the sealing material in the liquid crystal composition is below 100 ppm between an application and a hardening of the sealing material.

In another aspect of the present invention, there is provided a sealing material used bonding a first substrate and a second substrate and contacting with a liquid crystal composition, wherein the solubility of the sealing material in the liquid crystal composition is below 100 ppm.

[Embodiment of the Invention]

Reference will now be made in detail to one embodiment of a method for fabricating a liquid crystal display device (LCD) and a sealing material for an LCD in accordance with the present invention, examples of which are illustrated in the accompanying drawings.

Referring to Figure 1 and Figure 2, an LCD in accordance with an embodiment of the present invention has an array substrate (a first substrate) 100, a facing substrate (a second substrate) 200 disposed oppositely leaving a predetermined space to the array substrate 100, and a liquid crystal display panel (a liquid crystal cell) 10 having a liquid crystal layer 300 including a liquid crystal composition kept in a predetermined gap between the array substrate 100 and the facing substrate 200.

In such a liquid crystal display panel 10, a display area 102 displaying an image is formed in an area surrounded by an outer edge seal 106 bonding the array substrate 100 with the facing substrate 200. A periphery area 104, which has a line, a drive circuit, or a power supply line extracted from the display area 102, is formed in an outer area of the outer edge seal 106.

Referring Figure 2, in the display area 102, the array substrate 100 has mxn pixel electrodes 151 disposed in the matrix shape, m scan lines Y1 to Ym formed along a row direction of the pixel electrodes 151, n signal lines X1 to Xn formed along a column direction of the pixel electrodes 151, and mxn thin film transistors, i.e. pixels TFT 121, disposed as switching elements near the crossing location of the scan lines Y1 to Ym and the signal lines X1 to Xn corresponding to mxn pixel electrodes 151.

In the periphery area 104, the array substrate 100 has a scan line drive

circuit 18 for driving the scan lines Y1 to Ym, a signal line drive circuit 19 for driving the signal lines X1 to Xn, and so on. The scan line drive circuit 18 or the signal line drive circuit 19 consist of a complementary circuit composed of n-channel type thin film transistor and p-channel type thin film transistor. These thin film transistors are, for example, top gate type tin film transistors which use a poly-silicon thin film as an active layer.

As shown at Figure 2, a liquid crystal capacity CL is formed of the pixel electrode 151, a facing electrode 204, and the liquid crystal layer 300 interposed between these electrodes. Also, an auxiliary capacity Cs is formed electrically in parallel with the liquid crystal capacity CL. The auxiliary capacity Cs is formed by a couple of electrodes disposed oppositely through an insulation layer, i.e. an auxiliary capacity electrode 61 having the same potential with that of the pixel electrode 151 and an auxiliary capacity line 52 set as a predetermined potential. The auxiliary capacity electrode 61 is formed by poly-silicon thin film, and contacts with the pixel electrode 151. Also, the auxiliary capacity line 52 is formed by the same material with the scan line Y of one with a gate electrode 114.

These array substrate 100 and facing substrate 200 are bonded by the sealing material 106 in a state of forming a predetermined gap by a scan spacer (not shown). The liquid crystal layer 300 is injected and sealed in the predetermined gap formed between the array substrate 100 and facing substrate 200.

Next, a method for fabricating an LCD will be now described. Particularly, the so-called many side forming method, which forms a plurality of liquid crystal display panel simultaneously from a couple of large-sized mother glass substrates, will be described.

First, a plurality of the array substrates 100 is formed on the large-sized mother glass substrates. That is, forming and patterning of a metal film or an insulation film are repeated on the mother glass substrate with a thickness of 0.7 mm. Then, a semiconductor layer formed of poly-silicon thin film, a gate electrode of one with a scan line, a gate insulation film, an interlayer insulation film, a signal line of one with a source electrode, a drain electrode, a passivation film, a color filter layer, the pixel electrode, a scan spacer, an alignment film, and so on are formed in order.

Then, a plurality of the facing substrates 200 corresponding to the number of the array substrates is formed on the large-sized mother glass substrate. That is, forming and patterning of the metal film or the insulation film are repeated on the mother glass substrate with a thickness of 0.7 mm, and the facing electrode and the alignment film are formed in order.

Then, the sealing material 106 consisted of adhesive is printed and applied on the mother glass substrate which the array substrates 100 was formed on. At this time, the sealing material is applied in a loop shape surrounding a liquid crystal filling area for filling a liquid crystal composition.

For example, as shown at Figure 3A, in the mother glass substrate(a first substrate) 400M which the array substrates 100 was formed on, the sealing material 106 is applied in the loop shape to surround the liquid crystal filling area corresponding a display area of the each array substrates 100.

Then, as shown at Figure 3B, a liquid crystal composition 500 is dropped in an inner liquid crystal filling area 402 surrounded by the sealing material 106. At this time, an amount of the liquid crystal composition 500 dropped is more than a volume of the liquid crystal filling area of when a cell gap between a couple of the

substrates becomes a predetermined space, generally almost same as a volume of the liquid crystal filling area.

Then, as shown at Figure 3C, in a vacuum chamber, after the mother glass substrate 400M which the array substrate 100 is formed on is disposed, it becomes a vacuum state by exhausting. And then, the mother glass substrate 400 is put on a mother glass substrate 600M (a second substrate) which the facing substrate is formed on, such that the each alignment film is facing with and each rubbing direction is, for example, in an angle of 90°.

Then, as shown at Figure 3D, the atmospheric pressure is applied to the couple of mother glass substrates 400M and 600 and presses the glass substrates 400M and 600M uniformly by opening an inside of the vacuum chamber into an atmosphere. The scan spacer having a predetermined height is formed in the liquid crystal filling area 402 of the array substrate 100. Accordingly, a couple of the mother glass substrates 400M, 600M are pressed until they have a desired space by keeping the cell gap uniformly by the scan spacer. At this time, the sealing material 106 is not hardened completely, is pressed until a desired cell gap is made by pressing a couple of the substrates.

Then, in a state that the cell gap of a couple of the mother glass substrates 400M, 600M is pressed in a desired space, the sealing material 106 is hardened by irradiating ultraviolet rays selectively to the sealing material part and heating the substrates at 120 degrees C for about 1 hour. Thereby a couple of the mother glass substrates 500M, 600M are bonded.

Then, as shown Figure 3E, a plurality of the liquid crystal display panels 10 is cut from a couple of the mother glass substrates 400M, 600M.

Finally, polarizing plates are attached to an outer surface of the liquid

crystal display panel 10, i.e. a surface of the array substrate 100 and the facing substrate 200, and a liquid crystal display device is fabricated.

In accordance with the embodiment described above, the time required to inject and seal the liquid crystal composition is so shortened substantially, that a fabrication cost can be reduced.

By the way, the sealing material 106 applied to such a method contacts with the liquid crystal composition 500 dropped, before it is hardened completely. Thus, the solubility for the liquid crystal composition is preferably adjusted below 100 ppm. The sealing material 106 is, for example, an ultraviolet ray hardening resin, is adjusted as follows.

First, by a method shown at the following composition example, bisphenol A type epoxy resin partial methacryl, which is component a of the sealing material, is composed. That is, a high purity bisphenol A type epoxy resin : epiclon 850 S (made in Dainippon ink Chemical Industry) 1000 weight section, methacrylic acid : 250 weight section, toluene : 900 weight section, triethylamine : 2 weight section, paramethoxyphenol : 2 weight section are mixed, heated and stirred at 90 degrees C for 8 hours, and composed with a partial addition reactant.

The reactant is added by toluene : 4500 weight section and diluted, pure water : 4500 weight section is added to this and stirred at a room temperature for 1 hour, then is put gently, and moisture was separated and removed. After repeating a washing operation 5 times, a washing by 1 stipulation sodium hydroxide water solution of the same amount is repeated 5 times, and a washing by a pure water of the same amount is repeated 5 times. Then, toluene is removed thoroughly by filtering this solution and condensing it at 70 degrees C under reduced pressure, and bisphenol A type epoxy resin partial methacryl

chemical is purified.

In other component b to f of the sealing material, same process is performed and purified highly.

The sealing material, for example, was formed by mixing the following component a to f in a predetermined composition ratio.

a component : bisphenol A type epoxy resin partial methacryl purified by the above composition example : 56 weight section

b component : BPE4 (made in Daiichi pharmaceutical industry) : 5 weight section

c component : esacure KIP– 150 (made in Lamberti Co.) : 4 weight section

d component : amicure VDH (made in Ajinomoto) : 10 weight section

e component : XO2 M-2010 (Sinnittetsu chemistry) : 24 weight section

f component : KBM-403 (Sinethu chemistry) : 1 weight section

These a to f component is mixed thoroughly by using a paint roll, a sealing material A with a viscosity of about 500,000 centipoises was produced.

Next, the solubility of the liquid crystal composition of the sealing material A is measured. Also, here, ZLI-4792 : made in Merck Co. was used as the liquid crystal composition.

That is, after putting and sealing 0.5 g of the sealing material A and 4.5 g of the liquid crystal composition in an ampoule tube, it is put gently at 23 degrees C for 24 hours. Then, a top solution of the liquid crystal composition is took out, the solubility was measured by adding together a solution amount of each component of the sealing material using a gas chromatography analysis apparatus (14 A, made in Simazu). Consequently, the solubility of the above liquid crystal

composition of the sealing material A was 90 ppm.

Next, an LCD was fabricated by the above fabrication method using the sealing material A, and the existence of a poor display was tested. In accordance with the LCD, there was no poor display such as blowhole, white spot, baking, and so on, a good display quality was able to be realized. Also, when a cell for measuring a voltage maintenance rate was produced by the same method and a voltage maintenance rate was measured, it was as good as 99%.

(Comparison example) A sealing material B with a viscosity of about 100,000 centipoises was produced. The sealing material is adjusted by the same method except that a component of a sealing material b in the above embodiment was bisphenol A dimethacrylate : 5 weight section. The solubility of the sealing material B for the liquid crystal composition (ZLI-4792 : made in Merck Co.) was measured, and it was 300 ppm.

An LCD was fabricated by the above fabrication method using the sealing material B, a poor display such as white spot and baking generated on a picture. Moreover, when a voltage maintenance rate was measured, it was 89%.

In the same manner, an experiment was performed with various sealing materials. Consequently, in an LCD using a sealing material of which solubility is more than 100 ppm, a poor display generated.

In accordance with the method for fabricating an LCD and the sealing material for the LCD, in a dropping injection method capable of shortening time for injecting and sealing of a liquid crystal composition, a sealing material concerned for contacting with the liquid crystal composition before hardening is adjusted such that the solubility for liquid crystal composition becomes below 100 ppm. Consequently, melting of the sealing material for the liquid crystal composition was

restrained, and it becomes possible to prevent a pollution of the liquid crystal composition. Thus, it becomes possible to prevent from a poor display generating.

Moreover, since it is not necessary to harden a sealing material before pressing to make a desired cell gap of a liquid crystal layer, when a couple of the substrates are pressed, a sealing material is pressed easily, and it becomes possible to ensure a desired cell gap easily.

Accordingly, it becomes possible to mass-produce an LCD having a stably good display quality.

Moreover, in the present invention, a sealing material with the solubility below 100 ppm for a liquid crystal composition before hardening may be used, and a sealing material itself may be a heat hardening type resin, or an ultraviolet ray hardening type resin.

Moreover, an applying pattern of a sealing material is not necessary to be a loop shape, the existence of an air exhaustion hole and a liquid crystal exhaustion hole, the existence of a dummy pattern for an improvement of a gap flatness, etc. are not asked.

The substrates may be put upon under a vacuum or ordinary pressure.

Also, in the above embodiment, a sealing material was applied on a mother glass substrate which an array substrate was formed on, but the sealing material may be applied on the mother glass substrate which an facing substrate was formed on or on the both substrates.

[Effect of the Invention]

As described above, in accordance with the present invention, a method for fabricating a liquid crystal display device capable of injecting and sealing a liquid crystal composition in a short time, and mass-producing stably a liquid

crystal display device having a good display quality and a sealing material for a liquid crystal display device can be provided.

[Description of Drawings]

Figure 1 is a perspective view of a construction of a liquid crystal display panel in accordance with a method for fabricating a liquid crystal display device of the present invention;

Figure 2 is a circuit diagram of a construction of a liquid crystal display panel shown at Figure 1; and

Figure 3A to 3E are sectional views for illustrating one embodiment of a method for fabricating a liquid crystal display device of the present invention.

Description of reference numerals

100: array substrate

200: facing substrate

300: liquid crystal composition (liquid crystal layer)

400M: mother glass substrate (for array substrate)

402: liquid crystal filling area

500: liquid crystal composition

600M: mother glass substrate (for facing substrate)